

**ABSTRACT**

Improved methods for manufacturing semiconductor devices incorporating  
5 barrier layers at metal/dielectric interfaces include the use of nitrogen-rich plasma,  
ion beam implantation and/or electromagnetic radiation to form regions of nitrided  
metal. The barrier layers decrease the diffusion of dopants such as fluorine,  
phosphorous and boron from the dielectric material into the metal, thereby  
decreasing the formation of metal salts. By decreasing the formation of metal salts,  
10 the barrier layers of this invention decrease the formation of voids and areas of  
delamination, and thereby decrease the loss of electrical reliability during  
manufacture and during use. Additional aspects of this invention include methods  
for monitoring the deposition of thin metal films using sheet resistance  
measurements, and further embodiments of this invention include methods for  
15 monitoring the surface texture of films that undergo phase transitions. Additional  
embodiments include methods for monitoring and calibrating the temperatures of  
manufacturing processes on the surfaces of semiconductor wafers. Thus, useful  
lifetimes of semiconductor devices can be increased, and the manufacture of  
reliable devices can be easier, less expensive and more reproducible.